Letters to the Editor

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On the use of different formulae for ionospheric absorption calculation

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If a wave be travelling through an ionized region of the atmosphere, the absorption suffered by it for double passage during transmission is given by Jaeger (1947).

$$\int k\,ds = \frac{\nu_0 H}{c \sec \chi} F(f_c/f), \tag{1}$$

where k is the absorption suffered by any wave penetrating through unit distance; ds is an element of the region; χ, the solar zenith angle; c, the velocity and f, the frequency of the propagating waves; H, the scale height; ν_0, the collision frequency of electrons with neutral particles at the datum level; f_c, the critical frequency of the region under consideration. The function $F(f_c/f)$ was evaluated by Jaeger for different values of f_c/f.

Now eq. (1) can be written as

$$\int k\,ds = \frac{\nu_0 H}{c} \frac{f_0^2}{f^2} (\sec \chi)^{-3/2} \phi\,(f_c/f). \tag{2}$$

Here f_0 is the value of f_c at $\chi = 0$. The value of $\phi(f_c/f)$ was also evaluated by Jaeger himself.

It was pointed out by Jaeger that for $f_c << f$ the ratio $f_c/f \to 0$ and the value of $\phi(f_c/f) \to 4{\cdot}133$. Thus for $f_c << f$ the value of total absorption comes out to be

$$\int k\,ds = \frac{4{\cdot}133}{c} \nu_0 H \frac{f_0^2}{f^2} (\sec \chi)^{-3/2}, \tag{3}$$

i.e.,

$$\int k\,ds = 4{\cdot}133 \frac{\nu_0 H}{c \sec \chi} \frac{f_c^2}{f^2}. \tag{4}$$

The approximations made above are restricted to small values of f_c/f. Actually, for waves of low frequency the value of f_c/f is no longer small and the approximations could not be made above a considerable height. For waves of greater frequency this approximation may be applied to a certain height above which it fails. So, for cases where $f_c/f \to 0$ absorption may be calculated by eq. (4) where as for higher values of f_c/f formula (2) should be used, otherwise, considerable error will come in as would be evident from the graph.

The following workers have used the approximate formulae for calculating absorption at different places under different conditions :

Mitra & Mazumdar (1957) have used the formula originally deduced by Appleton (1937) for measurement of ionospheric absorption at Delhi using 5 MH_z waves,

$$\int k\,ds = 4{\cdot}13 \left(\frac{4\pi e^2}{mc}\right) \frac{N_0 \nu_0 H \cos^{3/2}\chi}{(p \pm |p_L|)^2}$$

where e is the charge of an electron, m, the mass of the electron; N_0 is the number of electrons at the level of maximum ionization for $\chi = 0$, p and p_L are the angular frequency and gyro-frequency respectively of the wave.

Beynon & Davies (1954) used the formula

$$\int k\,ds = 4{\cdot}13 \frac{\nu_0 H}{c} (f_0/f)^2 \cos^{3/2}\chi$$

for a study of vertical incidence in ionospheric absorption with 2 MH_z waves.

Misra & Chakravarty (1973) used the formula

$$\int k\,ds = 4{\cdot}133 \frac{\nu_0 H}{c \sec \chi} \cdot \frac{f_c^2}{f^2}$$

for studying the variation of transmission absorption with alitutude using 5 MH_z waves.

White & Straker (1939) have used the formula

$$\int k\,ds = 4{\cdot}13 \frac{\nu_0 H e^2 N_0}{mc} \frac{(\cos \chi)^{3/2}}{(f \pm |f_L|)^2}$$

(ds being the elementary thickness of the region) for studying the diurnal variation of absorption of wireless waves of frequencies 5·6, 6·3, 7·0 MH_z.

Rao, Mazumdar & Mitra (1962) have used the formula

$$-\log \rho = 4{\cdot}13 \left(\frac{4\pi e^2}{mc}\right) \frac{N_0 \nu_0 H (\cos \chi)^{3/2}}{(p \pm |p_L|)^2}$$

(ρ being the coefficient of reflection) for investigation of ionospheric absorption at Delhi at 5 and 2.5 MH_z waves.

It may be noted that the approximate formulae stated above are strictly valid only for $f >> f_c$. Actually these have been used by the above workers for low-frequency waves ranging from 2–7 MH_z. Here the ratio f_c/f will be small for small values of f_c i.e., at lower regions. But at greater f_c i.e., for higher regions the value of this ratio will not be so small as required by the formulae.

The values of absorption calculated by eqs. (2) and eqs. (4) are shown by curves I and II respectively in the fig. It is seen from the graphs that the values calculated from eq. (2) by using data from the Rocket Pannel (1952) and from Chapman & Little (1957) and taking Jaeger's values of $\phi(f_c/f)$ are higher than those calculated from (4). It may be mentioned here that for 5 MH_z waves the difference between these two values becomes considerable above 110 kms as shown in figure 1. At greater heights the value of f_c/f will be greater hence $\phi(f_c/f)$ also. As a

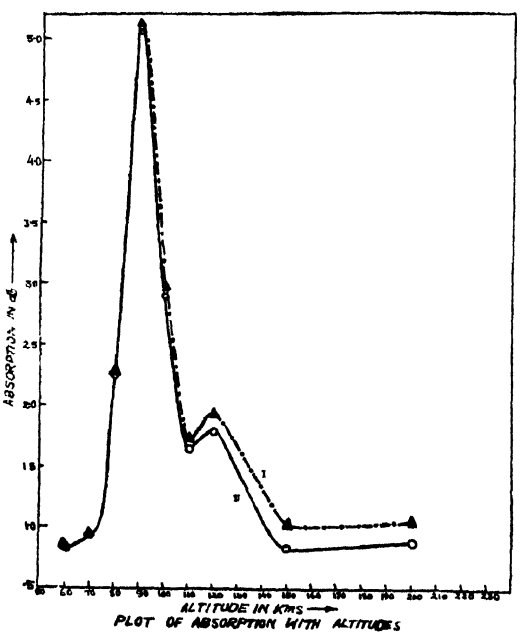

Fig. 1

result of this, the difference between the two values will be more prominent. The cause of this discrepancy lies in the fact that the formulae will not hold good for higher regions with 5 MH_z waves as the value of f_c/f will not be nearly zero and the value of $\phi(f_c/f)$ will not lie near 4·133. Thus for 5 MH_z waves, formula (4) may be used approximately below 110 kms above which it will not hold good. But for waves of higher frequency this formula will be true for greater heights. Thus by the use of eq. (4) at such low frequencies stated above for higher regions

errors would come in. The value of absorption calculated by eq.(4) will not give us correct value of total absorption. At greater heights these errors will be much magnified and will cause serious discrepancies in the determination of the properties (e.g. ν, N, H, T etc.) of ionospheric regions by observations of radio wave absorption in the ionosphere.

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Debye temperatures of succinimide and benzalazine

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Recently Eggert & Hänsel (1971) have calculated the Debye temperatures for naphthalene and anthracene from elastic constant data and compared it with the values calculated by Pawley (1967). In this short note we report the Debye characteristic temperatures calculated from the experimental elastic constants for the molecular crystals of succinimide and benzalazine.

The measured values of the elastic constants of orthorhombic succinimide and benzalazine crystals have been reported by Kashyap (1964) and Joshi & Kashyap (1964) respectively, from the thermal diffuse scattering of X-rays. Haussühl (1965) also determined the elastic constants of benzalzine, but the values of Joshi & Kashyap (1964) was preferred because of the correlation of their elastic data with the crystal structure of benzalazine. The method of Betts *et al* (1956) extended for crystals of orthorhombic symmetry proposed by Joshi (1961) has been followed, without being prohibitive in time and effort. The following equations have been used

$$\Theta = (h/k)(9N/16\pi^2 V)^{1/3}\rho^{-\frac{1}{3}}J^{-1/3}, \quad \ldots (1)$$